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## Amendments to the Specification

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BACKGROUND OF THE INVENTION

## 1. Field of the Invention

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The present invention relates to an improved structure of rotation support of heat-dissipation fan, wherein ceramic bearing is fixed on rotor and rotate with rotor, various ceramic axle tube supporting structures are provided and interior and exterior surface of bearing and axle tube are further processed to lower rotational friction thereof achieve lower noise, lower power consumption, longer life and higher speed.

## 2. Description of the Prior Art

FIG.1 is an exploded view of prior art heat-dissipation fan. The axial shaft 101 is fixed on rotor 100 at one end and surrounded by axle tube 102 with either ball bearing 103 or metal sleeve 104 supports. When stator coil 105 is energized to generate impelling magnetic force, the circular permanent magnet installed inside rotor 100 will act upon the magnetic force and rotate the rotor. The ball bearing 103 or metal sleeve 104 is key component to fan rotation in prior art. Ball bearing 103 has lower friction and longer life but when dust or debris goes into ball bearing, the bearing function rapidly deteriorate generating vibration, abnormal heat and loud noise and become unusable. In addition, the price of ball bearing is among the highest compared with other solutions. The metal sleeve 104 is cheap but wears out very quick which require regular maintenance check and replacement. When lubricant of these prior art is consumed, abnormal heat and friction will greatly shorten the life of prior art fan.

In addition, axial shaft 101 is fixed on rotor and rotate with rotor while metal sleeve 104 is fixed on fan base and do not rotate, the friction caused by whole surface contact between them and viscosity of lubricant will offset impelling force create by magnetic force, resulting high heat, high friction, lower rotor speed and wasting of energy.

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## BACKGROUND OF THE INVENTION

The present invention intends to improve the structure of rotational supports for heat-dissipating fans, wherein conventional units are swapped for ceramic components. Various ceramic bearings and axle tube-support structures are used in three embodiments.

The interior and exterior surfaces of these ceramic components are processed to either: 1) provide better bonding surfaces with the fan-rotor or 2) to reduce rotational friction, thereof lowering noise and power consumption while extending life and achieving higher rotational speeds.

### SUMMARY OF INVENTION


Accordingly, the object of the present invention is to provide an improved structure of rotation support of heat dissipation fan to achieve lower rotational friction, lower noise, lower power consumption, longer life and higher speed.

u2 In order to achieve above objectives, the present invention provide an improved structure comprising ceramic hollow bearing passing thru and fixed on rotor and rotate with rotor, ceramic hollow or solid axle tube passing through the inside of bearing and rotate freely or fixed to fan body to provide low friction and high speed rotation. Exterior surface of bearing is formed or ground to provide better connection with rotor while interior of bearing and exterior of axle tube are further processed to reduce surface contact area thereof lower rotational friction.

The first preferred embodiment of the present invention comprising a ceramic hollow tube shape bearing, support bearing and axle tube and a ceramic holding ring. The bearing passes through and fix on fan rotor and rotate with the rotor while the support bearing fixes on fan base and work as structural support, which do not rotate. The axle tube is cylindrical shape or with an end flange portion forming a T shape tube and the axle tube pass through the inside of bearing and support bearing and rotate asynchronously and freely with fan rotor. The axle tube functions as structural support, providing multi point contact rotating support mechanism. The ceramic holding ring has an opening gap and is installed at one end of axle tube to limit the axial movement of axle tube.

When the heat dissipation fan is energized and in rotation, the bearing is rotating with the rotor and the axle tube will be carried forward asynchronously and rotating slowly within the bearing. Since the bearing and axle tube are rotating at different speeds in the same direction, it will greatly reduce friction and increase fan speed and efficiency.

To avoid axial direction movement of axle tube, a ceramic holding ring is installed at the end of axle tube. Rotating bearing, fixed support bearing, free moving axle tube and auto balancing of magnetic force will create a very stable high speed multi-point contact rotating support mechanism with minimum vibration and friction.

 The bearing and support bearing are ceramic hollow tubes, the exterior of bearing and support bearing are formed or ground to concave surface with smaller outer diameter or non-circular shape or concave groove shape to provide a simple but solid connection with fan rotor body and is suitable for mass production of embedded injection molding of fan rotor body. The interior of bearing and support bearing are formed or ground with concave grooves to further reduce surface contact surface and friction among bearing, support bearing and axle tube.

The axle tube is solid or hollow ceramic tube with cylindrical shape or with an end flange portion forming a T shape, the exterior of axle tube is formed or ground with concave grooves or with non-circular shape to further reduce surface contact surface and friction among bearing, support bearing and axle tube.

In addition, the gap between bearing/support bearing and axle tube is kept below 10  $\mu\text{m}$  to avoid rotation vibration and noise.

The second preferred embodiment of the present invention comprising a ceramic hollow tube shape bearing and axle tube and a ceramic holding ring. The bearing passes through and fixes on fan rotor and rotating with the rotor. The axle tube is cylindrical shape or with an end flange portion forming a T shape tube and the axle tube pass through the inside of bearing and fixed on fan base to provide structural support and multi-point contact rotating support mechanism. The ceramic holding ring has an opening gap and is installed at one end of axle tube to limit the axial movement of axle tube. As stated in the first preferred embodiment of present invention, the interior of bearing and exterior of axle tube can be further processed to reduce surface contact and friction and the exterior of bearing can be further processed to provide a simple but solid connection with fan rotor body that is suitable for mass production of embedded injection molding of fan rotor body.

The third preferred embodiment of the present invention comprising a pair of ceramic hollow tube shape bearings, a ceramic hollow axle tube and a ceramic holding

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~~ring. The bearings pass through and fix on rotor upper body and rotor lower body respectively and rotate with the rotor. The axle tube is a cylindrical hollow tube, which passes through the inside of both bearings and connects the center of front and rear fan body support frame. The axle tube does not rotate and work as structural support to provide multi-point contact rotating support mechanism. The ceramic holding ring has an opening gap and is installed at both ends of axle tube to limit the axial movement of axle tube. As stated in the first preferred embodiment of present invention, the interior of bearing and exterior of axle tube can be further processed to reduce surface contact and friction and the exterior of bearing can be further processed to provide a simple but solid connection with fan rotor body that is suitable for mass production of embedded injection molding of fan rotor body.~~

~~The axle tube is fixed and connecting the center of front and rear fan body support frame while fan coil/electronic control circuit board is fixed on the axle tube and external power source is connected thru an opening slot on axle tube. The rotor upper and lower bodies form a closed area to contain the rotation support structure of heat dissipation fan and fan coil/electronic control circuit board, preventing dust and particles accumulation. The present invention is very useful for high contamination and hostile environment.~~

~~The above and other objects, feature and advantages of the present invention will become clear from the following description based upon the accompanying drawings, which illustrate examples of preferred embodiment of the present invention.~~

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## SUMMARY

The primary objective of this invention is to improve the structure of rotational supports for heat-dissipation fans through reduction of rotational friction to lower noise, power consumption and at the same time increasing the life and operational speeds.

Secondary objectives, advantages and features of this invention will be clarified in the following detailed description when viewed with accompanying drawings.

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## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

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FIG.2 is the exploded view of present invention. The ceramic hollow tube bearing-2

passes through and fixes on fan rotor 100 and rotating with the rotor. The ceramic hollow tube support bearing 4 passes thru and fixes on fan base 107. The axle tube 6 is cylindrical shape or with an end flange portion forming a T shape tube, which passes through the inside of bearing 2 and support bearing 4 and rotate asynchronously and slowly with rotor 100. The ceramic holding ring 8 has an opening gap and is installed at one end of axle tube to limit the axial movement of axle tube.

When the fan is energized and in rotation, the bearing 2 is rotating with the rotor 100 and the axle tube 6 will be carried forward asynchronously and rotating slowly within the bearing 2 and support bearing 4. Since the bearing 2 and axle tube 6 are rotating at different speeds in the same direction, it will greatly reduce friction and increase fan speed and efficiency. To avoid axial direction movement of axle tube, a ceramic holding ring 8 is installed at the end of axle tube. Rotating bearing 2, fixed support bearing 4, free moving axle tube 6 and auto balancing of magnetic force will create a stable high speed multi-point contact rotating mechanism with minimum vibration and friction.

FIG.3a, FIG.3b, FIG.3c shows the cross sectional, bottom and top view of axle tube 6 respectively. The exterior of axle tube 6 is formed or ground with concave grooves or with non-circular shape to reduce surface contact thereof friction between bearing 2, support bearing 4 and axle tube 6.

FIG.4a, FIG.4b shows cross sectional and top view of bearing 2 and support bearing 4 respectively. The exterior of bearing 2 and support bearing 6 are formed or ground to concave surface with smaller outer diameter or non-circular shape or concave groove shape to provide a solid connection with fan rotor 100. The interior of bearing 2 and support bearing 4 are formed or ground with concave grooves to reduce surface contact thereof friction among bearing 2, support bearing 4 and axle tube 6.

FIG.4c shows cross sectional view of embedded ceramic bearing 2 in injection molding of fan rotor 100. The exterior of bearing 2 and support bearing 6 are formed or ground to concave surface with smaller outer diameter or non-circular shape or concave groove shape to provide a solid connection with fan rotor 100. The present invention is very useful in producing small and thin rotor fan.

FIG.5 shows cross sectional view of the first preferred embodiment of the present invention comprising a ceramic hollow tube shape bearing 2, support bearing 4 and axle

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~~tube 6 and a ceramic holding ring 8. The bearing 2 passes through and fixes on fan rotor 100 and rotating with the rotor while the support bearing 4 fixes on fan base 107 and works as structural support which do not rotate. The axle tube 6 is cylindrical shape or with an end flange portion forming a T shape tube and the axle tube 6 pass through the inside of bearing 2 and support bearing 4 and rotating asynchronously and freely with fan rotor 100. The axle tube 6 functions as structural support to provide multi-point contact rotating support mechanism. The ceramic holding ring 8 has an opening gap and is installed at one end of axle tube 6 to limit the axial movement of axle tube.~~

~~FIG.6 shows cross sectional view of the second preferred embodiment of the present invention comprising a ceramic hollow tube shape bearing 2 and axle tube 6 and a ceramic holding ring 8. The bearing 2 passes through and fixes on fan rotor 100 and rotating with the rotor. The axle tube 6 is cylindrical shape or with an end flange portion forming a T shape tube and the axle tube passes through the inside of bearing 2 and fixes on fan base 107 to provide structural support and multi-point contact rotating support mechanism. The ceramic holding ring 8 has an opening gap and is installed at one end of axle tube 6 to limit the axial movement of axle tube.~~

~~FIG.7 shows cross sectional view of the third preferred embodiment of the present invention comprising a pair of ceramic hollow tube shape bearings 202 and 204, a ceramic hollow axle tube 206 and a ceramic holding ring 208. The bearings 202, 204 pass through and fix on rotor upper body 210 and rotor lower body 212 respectively and rotating with the rotor. The axle tube 206 is a cylindrical hollow tube, which passes through the inside of both bearings 202, 204 and connects the center of front and rear fan body support frame 214, 216. The axle tube 206 does not rotate and work as structural support to provide multi-point contact rotating support mechanism. The ceramic holding ring 208 has an opening gap and is installed at both ends of axle tube to limit the axial movement of axle tube.~~

~~The axle tube 206 is fixed and connecting the center of front and rear fan body support frame 214, 216 while fan coil/electronic control circuit board 218 is fixed on the axle tube 206 and external power source is connected thru an opening slot 220 on axle tube. The rotor upper body 210 and lower body 212 form a closed area to contain the rotation support structure of heat dissipation fan and fan coil/electronic control circuit~~

board 218, preventing dust and particles accumulation. The present invention is very useful for high contamination and hostile environment.

FIG.8 shows front and rear view of fan body in the third preferred embodiment of the present invention. The axle tube 206 passes through the inside of both bearings 202, 204 and connects the center of front and rear fan body support frame 214, 216.

There is no special restriction to the manufacturing process of hollow ceramic tube bearing 2, 202, 204, support bearing 4, hollow ceramic axle tube 6, 206 and ceramic holding ring 8, 208 of present invention. The preferred embodiments of the present invention are using metal oxide ceramic powders e.g. aluminum oxide, zirconium oxide, silicon oxide, etc., or a mixture of two or more oxides powder are used and formulated with binding material. After molding, ceramic green bodies are debinded in low temperature then sintered in high temperature to produce high mechanical strength and durable ceramic blanks. Ceramic blanks require further precision processes to become ceramic bearing 2, 202, 204, support bearing 4 and axle tube 6, 206. Precision grinding and polishing then apply to ceramic blanks to achieve near true circular shape to maintain low vibration and low noise rotation. Ceramic holding rings 8, 208 are made from ceramic blanks by slicing ceramic blanks into circular rings then cutting an opening slot on each ring.

Therefore, compared with prior art, advances of the present invention may be concluded as follows:

1. The present invention provides an improved structure of rotation support of heat dissipation fan by utilizing high mechanical strength and durable ceramic for bearing, support bearing and axle tube to replace high price ball bearing or low quality metal sleeve. In addition, various bearing and axle tube supporting structures are provided and interior and exterior surface of bearing and axle tube are further processed to lower rotational friction thereof resulting a new heat dissipation fan with lower noise, lower power consumption, longer life and higher speed.
2. The present invention provides a very useful mass production method for small and thin rotor fan. The exterior surface of bearing and support bearing are formed or ground to concave surface with smaller outer diameter or non-circular shape or concave groove shape to provide a simple but solid connection with fan rotor body

and is suitable for mass production of embedded injection molding of fan rotor body.

3. ~~The third preferred embodiment of present invention provides a very useful solution for high contamination and hostile environment. The rotor upper and lower bodies form a closed area to contain the rotation support structure of heat dissipation fan and fan coil/electronic control circuit board, preventing dust and particles accumulation.~~

~~The present invention has been described using foregoing preferred embodiments. However, it is to be understood that the scope of the present invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements. The scope of the claims, therefore, should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.~~

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Before the three embodiments of this invention are explained, features and advantages of each individual components of this invention are first outlined.

With reference to FIG.4a and FIG.4c, the hollow ceramic tube bearing 2 is formed or milled to achieve a concave exterior surface in order to be securely attached to fan rotor 100. The inner surface of bearing 2 is polished to lower rotational friction when in contact with axle tube 6. Similarly, the interior surface of the hollow ceramic support tube 4 is also polished to lower rotational friction when in contact with axle tube 6. With reference to FIG.4a, the exterior of support tube 4 is formed or milled in a similar fashion as ceramic tube bearing 2 to provide better connection with fan base 107.

As seen in FIG.2 and FIG.3a, the ceramic axle 6 can either be a hollow ceramic tube or a solid ceramic cylinder with a flanged top portion forming a T-shape when viewed from the side. The exterior of ceramic axle 6 is formed or milled into non-circular shapes or scored with grooves to reduce contact area with bearing 2 and support tube 4. The T-shaped ceramic axle 6 can be constructed by attaching a retaining device to either a solid ceramic rod or a hollow ceramic tube.



FIG.5 illustrates the first preferred embodiment of the present invention which comprises of a hollow ceramic tube bearing 2 which attaches to fan rotor 100, a ceramic support tube 4 which attaches to fan base 107, a ceramic axle tube 6 that passes through tube bearing 2 and support tube 4 and a gapped retaining ring 8 that clamps to axle tube 6 at the bottom of fan base 107 and holds the fan rotor assembly intact.

When the fan is at rest, the magnetic force exerted by the permanent magnets 106 onto the starter coil 105 will keep the fan rotor assembly 100 hovering above fan base 107 as prior art. The retaining ring 8 keeps the fan rotor assembly from leaving the fan base.

When the starter coil is energized and the fan is in motion, the ceramic tube bearing 2 with attached fan rotor revolves around axle tube 6 while fan base 107 and support bearing 4 stay stationary. In case when axle tube 6 comes into contact with ceramic tube bearing 2, axle tube 6 will be carried forward in the same direction as the fan rotor 100 and ceramic bearing 2 assemblies at slower speeds.

Since axle tube 6 does not remain static, rotational resistance between ceramic components tube bearings 2, support tube 4 and axle tube 6 is kept at a minimum, thereof reducing friction, the principal cause for excess heat, noise and vibration in fan assemblies.

The second preferred embodiment of the present invention comprises of a hollow ceramic tube bearing, a ceramic axle tube and a retaining ring. With reference to FIG.6, the hollow ceramic tube bearing 2 is fixed onto fan rotor body 100. The ceramic axle tube 6 passes through the fan rotor assembly and is fixed onto fan base 107. Unlike the first preferred embodiment, the ceramic axle tube 6 in the second embodiment does not rotate, but rather acts as structural support and multi-point contact rotating support mechanism. The gapped retaining ring 8 clamps onto ceramic axle tube 6 at the bottom of fan base 107 to limit lateral movement of the central axle assembly. Similar to the first preferred embodiment, fan rotor 100 is kept from coming into contact with fan base 107 by the magnetic forces exerted by the permanent magnets 106 onto the starter coil 105.

The third preferred embodiment of the present invention comprises of a pair of hollow ceramic tube bearings, a hollow ceramic axle tube and a pair of gapped retaining rings. FIG.7 shows the cross sectional view of the third preferred embodiment of the present invention. The two hollow ceramic bearings 202 and 204 pass through and fix onto the upper and lower rotor bodies 210 and 212 respectively. Like the previous two preferred embodiments, the hollow ceramic axle tube 206 passes through bearings 202 and 204 and connects the fan assembly to two central points on the fan's outer frame 214 and 216. The axle tube 206 does not rotate and acts only as a multi-contact-point support mechanism for bearings 202 and 204. The gapped ceramic retaining rings 208 are installed at both ends of axle tube to limit lateral movements of the axle tube.

The fan rotor's upper and lower bodies 210 and 212 form a sealed compartment when fully assembled and houses the fan coil and electronic-control circuit board 218 which is fixed onto axle tube 206 and has an opening 220 on axle tube 206 for running wires to the starter coil 215. The sealed rotor design helps to reduce dust and micro particles from entering the fan rotor assembly, thus, the third embodiment of this invention is suitable for operating under high contaminant and hostile environments.

FIG.8 shows the top-view of the front- and rear-sides of the fan body in the third preferred embodiment of the present invention when the fan is placed on a flat surface. The axle tube 206 passes through ceramic bearings 202 and 204 and connects the centers of the front and rear fan body support frames at 214 and 216.

There are no special restrictions to the manufacturing processes of hollow ceramic tube bearings 2, 202 and 204, support tube 4, hollow ceramic axle tubes 6 and 206 as well as the gapped retaining rings 8 and 208 of the present invention. Metal oxide ceramic powders such as aluminum oxide, zirconium oxide, silicon oxide and the likes or a mixture of two or more oxide powders formulated with binding materials are the preferred materials used for the manufacturing of these ceramic components. After initial molding, ceramic green bodies are first separated in low temperature then sintered in high

temperature to produce high mechanical-strength and durable ceramic blanks. These ceramic blanks will undergo further precision milling and polishing to produce ceramic bearings, support bearings and axle tubes suitable for the embodiment of this invention.

In comparison with prior art, advantages of the present invention are noted as follows:

1. The present invention improves the structure of rotational supports for heat-dissipating fans by utilizing high strength and durable ceramic components in place of conventional bearings and supports. In addition, these processed and polished ceramic components help decrease rotational friction, thereof reducing noise and power consumption while increasing the life and operational speeds for heat-dissipating fans.
2. The present invention provides a useful method for mass producing heat-dissipating fans that require less frequent maintenance checks and replacements.
3. The third preferred embodiment of the present invention provides an improved structure for fans used in high contaminant and hostile environments.

The present invention has been described using foregoing preferred embodiments. However, it is to be understood that the scope of the present invention is not limited to the disclosed embodiments. On the contrary, these embodiments intend to embrace various modifications and/or similar arrangements. The scope of the claims, therefore, should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

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#### ABSTRACT

24 ~~An improved structure of rotation support of heat dissipation fan comprising ceramic hollow tube bearing passes through and fixes on fan rotor and rotating with rotor, hollow or solid ceramic axle tube passes through the inside of bearing and rotating freely or fixed to fan body to provide low friction and high speed rotation. Exterior surface of bearing is formed or ground to provide better connection with rotor body while interior of bearing and exterior of axle tube are further processed to reduce surface contact area~~